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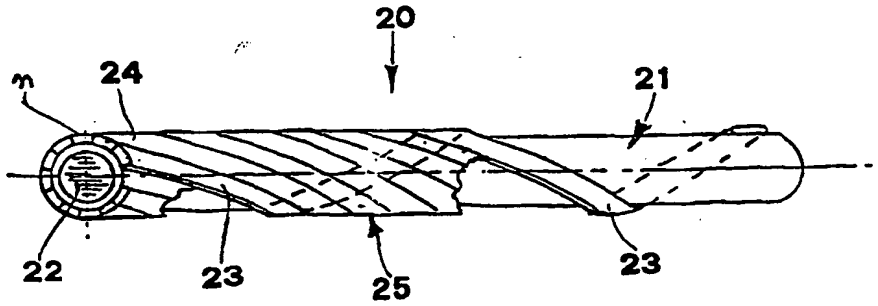

(57) Abstract

Electric windings (20) for inductors and transformers made of stainless steel tubular elements (21) cooled by demineralized wate (22), coated by a layer (25) of flat wires (23, 24, n) laid side by si and helically wound.

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ELECTRIC WINDINGS FOR INDUCTORS AND TRANSFORMERS HAVING WATER-COOLED TUBULAR ELEMENTS AND A HELICALLY WOUND COATING OF FLAT WIRES

The invention concerns windings for inductors and transformers used especially in railway vehicles.

To reduce losses and particularly to reduce variation of inductance as frequency varies, use is made of conductors whose components are insulated one from another.

To reduce weight and bulk of windings and increase current density, cooling is done by pressurized air and by oil.

Bearing in mind the danger which oil might represent in the event of an outbreak of fire and to increase efficiency, water, especially demineralized water, has recently been used for cooling purposes.

This is an advantage because water insulates but on the other hand it also corrodes some metals such as copper and pure aluminium.

For this reason steel and aluminium alloys such as Anticorodal have been resorted to.

Even so, certain disadvantages have been noted.

Resistivity and therefore resistance of the Anticorodal alloy, and losses in direct current, are about one third greater than those that occur with pure aluminium.

As frequency increases the current tends to become denser inside causing a reduction of space needed for its passage; this increases resistance in alternating current and losses, and a reduction in inductance value.

If violent surges of current take place the turns on the tube tend to widen causing tractive stresses making it necessary to use material with adequately sized cross sections.

The above invention lessens these disadvantages as will be explained below.

The invention concerns electric windings, for inductors and transformers, consisting of a tubular element cooled by internal circulation of liquid and coated with helically wound wires.

These wires are laid symmetrically side by side and are insulated one from another.

Varying from one case to another said wires are flat or round.

The most suitable liquid for cooling is demineralized water, but it may also be oil.

Coating wires may be of aluminium or copper.

The tubular elements may be of steel or of an aluminium alloy, especially Anticorodal.

The coating, of copper wires or flat wires, forms a continuous layer.

There may be two or more layers, one over another.

The advantages offered by the invention are evident.

Thermal head between tube, wires and flat wires, is very small.

Current is equally distributed among wires and flat wires whatever the frequency may be and no stray current is created.

Resistivity of copper is less than half that of aluminium alloy and losses in direct current are therefore low.

As frequency increases the current is distributed over all wires and flat wires which means only a very slight increase of resistance in alternating current.

Current is distributed uniformly around the tubular elements so that when frequency varies inductance value remains substantially constant.

In the event of a violent surge of current, the cross section of the tube, especially if made of steel, greatly assists in withstanding tractive stresses.

Windings are less costly than those at present used.

While the tube, especially a steel tube, wires and flat wires, all share the effort of withstanding tractive stresses, in the winding stage these stresses are borne by the tubular element only since the wires and flat wires, by their very nature, bend with little effort.

In view of the above, the overall cross section required for the tubular element, wires and flat wires is smaller than that needed for the conductor only, for example an Anticorodal tube.

Characteristics and purposes of the invention will be made still clearer by the following example of its execution illustrated by diagrammatically drawn figures.

Fig.1 Winding of the usual type made from a tubular element of Anticorodal, cut through lengthwise.

Fig.2 A length of the tubular element of a winding as here invented, drawn in a straight line.

The winding 10 of a type at present known is made from a tube 11 of Anticorodal helically bent with turns 12. Demineralized water 14 runs through the inside 13 of the tube.

The winding 20, subject of the invention, is made of a tube 21 of stainless steel through which demineralized water 22 runs.

Around the tube is a helical coating consisting of a number of flat wires 23, 24, n.

Said flat wires are insulated, laid symmetrically side by side so as to form a substantially continuous layer 25.

For the sake of simplicity the tube has been drawn in a straight line.

CLAIMS

1. Electric windings (20) for inductors and transformers made from tubular elements (21) cooled by interna circulation of liquid (22)
characterized in that the tubular element (21) is coated with helically wound wires (23, 24, n).

2. Electric windings (20) as in claim 1, characterized in that the coating wires (23, 24, n) are laid symmetrically side by side and are insulated one from another.

3. Electric windings (20) as in claim 1, characterized in that the conductors forming the coating are flat wires (23, 24, n).

4. Electric windings (20) as in claim 1, characterized in that the conductors forming the coating are wires.

5. Electric windings (20) as in claim 1, characterized in that the cooling liquid is demineralized water.

6. Electric windings (20) as in claim 1, characterized in that the cooling liquid is oil.

7. Electric windings (20) as in claim 1, characterized in that the conductors (23, 24, n) of the coating are made of aluminium.

8. Electric windings (20) as in claim 1, characterized in that the conductors (23, 24, n) of the coating are made of copper.

9. Electric windings (20) as in claim 1, characterized in that the conductors (23, 24, n) forming the coating are made of steel.

10. Electric windings (20) as in claim 1,

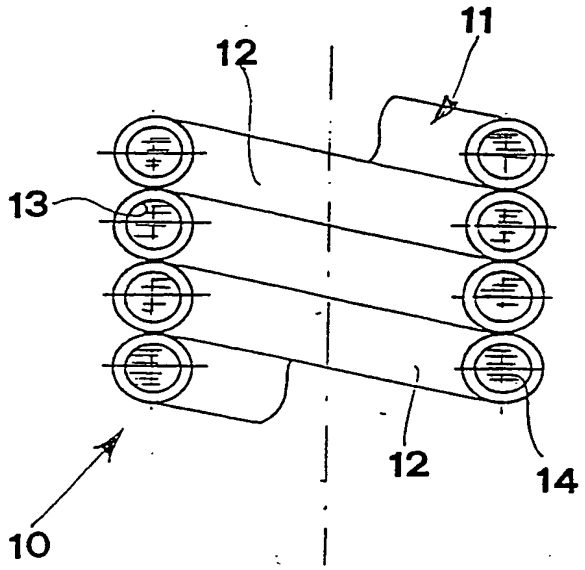
characterized in that the tubular element (21) is made of steel.

11. Electric windings (20) as in claim 1, characterized in that the tubular element (21) is made of an aluminium alloy, especially Anticorodal.

12. Electric windings (20) as in claim 1, characterized in that the coating forms a single substantially continuous layer (25).

13. Electric windings (20) as in claim 1, characterized in that the coating consists of two or more substantially continuous layers, one superimposed over another.

fig. 1



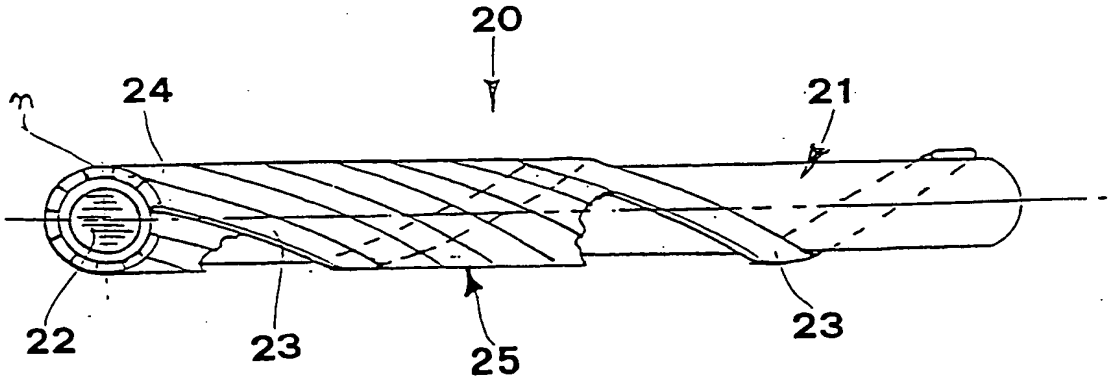


fig. 2

INTERNATIONAL SEARCH REPORT

Int ·onal Application No
PCT/IT 94/00012

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01F27/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CA,A,1 210 464 (BURKE, PATRICK) 26 August 1986 see page 12, paragraph 2 - page 13, paragraph 2	1,2,4,5, 7,8,10, 12,13
A	DE,A,15 14 142 (LEPPER) 17 April 1969 see page 2, line 6 - line 7	3,6
A	US,A,3 946 349 (THE U.S. OF AMERICA AS REPRESENTED BY THE SECRETARY OF THE AIR FORCE) 23 March 1976	
A	PATENT ABSTRACTS OF JAPAN vol. 6, no. 215 (E-138) (1093) 28 October 1982 & JP,A,57 118 614 (KANSAI DENRIYOKU K.K.) see abstract	

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☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
6 October 1994	12. 10. 94

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CA-A-1210464	26-08-86	NONE	
DE-A-1514142	17-04-69	NONE	
US-A-3946349	23-03-76	NONE	